5.9 GEOLOGY AND SOILS

Kleinfelder, Inc. completed a geologic reconnaissance and evaluation of the Ponto Area in July 2006 with regards to potential geologic and/or seismic hazards. These hazards include landslides, erosion, liquefaction, fault rupture, seismic shaking, tsunamis, flooding, expansive soils, and collapsible soils. The following sections discuss these hazards and their potential impact at this site in more detail. The geotechnical assessment is included as Appendix H of this EIR.

5.9.1 Existing Conditions

5.9.1.1 Geology

Regional Setting

The project site is located within the coastal region of the Peninsular Ranges geomorphic province (Norris and Webb, 1990). This province stretches for several hundreds of miles south from the Los Angeles area to the tip of Baja California. It is anchored by Cretaceous-age igneous rocks of the Southern California Batholith and contains various Jurassic-age metamorphic rocks (as roof pendants), often situated as isolated blocks within the igneous rocks.

The western coastal zone of San Diego County is dominated by a westward thickening wedge of sedimentary units that were deposited on the igneous and metamorphic rocks described above. These sedimentary units can be divided into three packages of deposits based on their sequence and age of deposition. The oldest sequence consists of claystone, siltstone, sandstone, and conglomerate deposited during late Cretaceous time. The second sequence of sediments was deposited during the Tertiary (Eocene and Pliocene) and consists of a variety of claystone, siltstone, sandstone, and conglomerate.

The most recent sedimentary deposits consist of early to late Pleistocene near shore marine, estuarine, and delta deposits (paralic deposits). The majority of these sediments were deposited on wave cut surfaces developed in response to sea level fluctuations and regional tectonic uplift during the Pleistocene. The oldest deposits are typically identified as the Linda Vista Formation (Qvop) and consist of conglomerate and sandstone with minor clay and silt strata. The youngest terrace deposits (late Pleistocene) are known as the Bay Point Formation (Qop) and have been mapped throughout the coastal region of San Diego County. The Pleistocene period resulted in the formation of the benched terrace mesas within the coastal region of San Diego County and the development of the east to west system of drainages that dissected the now elevated terraces and empty into the Pacific Ocean.

Project Setting

The project site resides on a beach-parallel terrace with an average elevation of approximately 50 feet above mean sea level (amsl); refer to Figure 5.9-1 (identified as Qop6-7). This terrace is typically underlain by reddish brown sand, silt and gravel deposits and range from 10 to 20 feet in thickness below the site. Inspection of the deposits in exposed cuts along the San Diego Northern Railroad revealed that they consist mostly of brown to reddish brown poorly sorted sands. The reddish brown coloration is caused by late Pleistocene pedogenic soil development processes that leach and concentrate hematite.

Soils

Four soil/geologic units were identified within the Ponto Area. These include residual soils, artificial fill soils, Quaternary terrace deposits, and Eocene age Santiago Formation.

Residual Soils

These soils include near-surface units consisting of natural pedogenic topsoil and other shallow near-surface units consisting of colluvium. The topsoil units are generally weakly developed where observed and are less than two feet in thickness. Colluvium was not directly observed, but is expected to have accumulated in low-lying drainages and/or depressions. These soils are anticipated to be less than two feet in thickness, based on the low topographic relief of the site.

Artificial Fill

An approximate 200-foot long embankment fill slope ascends to Carlsbad Boulevard near the mid-portion of the western property boundary. This fill slope reaches to approximately 10 feet in height, with a gradient of 1.5:1. A second embankment fill is located on-site and was created as part of the bridge approach for Avenida Encinas, which over crosses the San Diego Northern Railroad (SDNR) tracks to the east of the site. Minor grading has also occurred for the adjacent railway and on-site roads, as well as the existing residential and light-industrial uses, and is assumed to have consisted of cuts and fills of less than five feet in depth.

Quaternary Terrace Deposits

The site is underlain by geologically recent units comprised of terrace material which were deposited on a wave cut platform during the late Pleistocene period. These units are up to 10 to 20 feet in thickness and consist of a reddish-brown, medium grained silty sand in a weakly cemented condition.

Eocene Santiago Formation

The terrace deposit has been uncomfortably deposited on top of older Eocene age Santiago Formation. This unit typically consists of a medium to coarse-grained sand with occasional beds or claystone. The material is generally light gray to greenish gray in color and is weakly to moderately cemented.

5.9.1.2 Seismicity

Tectonism and faulting in the southern California region is controlled by strain release across the San Andreas Fault System. The San Andreas Fault stretches from the Gulf of California in Mexico along a northwest alignment through the desert region of Southern California up to Northern California, where it trends offshore north of San Francisco.

The major faults east of San Diego County include the San Andreas Fault, the San Jacinto fault and the Elsinore fault; refer to Figure 5.9-2. Major faults west of San Diego include the Palos Verdes-Coronado Bank fault, the San Diego Trough fault, and the Santa Clemente fault. The most dominant zone of faulting within the San Diego region are several faults associated with the Rose Canyon Fault Zone (RCFZ).

Several offshore fault features are located near the project site. These faults include both potentially active and active faults. The closest active faults are associated with offshore extensions of the Rose Canyon Fault Zone and occur approximately three to five miles west of the site.

Several onshore faults have also been mapped near the project site. The regional geologic map shows a notable fault strand approximately two miles northeast of the site; refer to Figure 5.9-2. Several similar fault features have been mapped in the Santiago Formation in the beach bluffs one mile south of the site, beyond Batiquitos Lagoon. These faults are generally classified as being only potentially active. No known active or potentially active fault related features are known to exist on the subject site.

Ground Shaking

Ground shaking may potentially occur on-site as the result of earthquake activity along a major fault, most likely along the regional Rose Canyon Fault, due to its proximity. Ground motion at the site, estimated through the California Geologic Survey website, indicates a maximum horizontal acceleration of 0.3g at a 10% probability of being exceeded in a 50-year period. This acceleration rate is used to classify Uniform Building Code (UBC, 2001) minimum building design requirements.

Ground Rupture

No active or potentially active faults were identified on-site in the geologic analysis. Therefore, the risk of on-site ground rupture along an existing fault is considered to have a low chance of occurrence.

Liquefaction

Liquefaction is generally caused when a loose (unconsolidated), cohesionless, saturated soil looses its shear strength (liquefies) during periods of ground motion caused by an event such as seismic shaking induced by an earthquake. Liquefied soils undergo significant loss in support capacity, which can result in catastrophic settlement of structures. Soils prone to liquefaction consist of poorly consolidated sands and sandy silts in areas of high groundwater. These types of soils are typically deposited within low-lying drainage channels and alluvial valleys influenced by fluvial processes. The subject site does not contain alluvial soils and depth to groundwater is estimated at approximately 50 feet bgs, thereby reducing the chance for liquefaction to occur on-site.

Dynamic Settlement and Settlement

Settlement of soils can be the result of seismic activity, particularly in unstable sands. Varying conditions, such as soil moisture, density, and material shape, can increase the potential for settlement to occur, due to seismic shaking.

Tsunami

Tsunamis are large sea waves that result from vertical displacement of ocean bottom faults or movement of submarine landslides. The resulting wave can travel at hundreds of miles an hour over thousands of miles across the ocean. Near shore, the waves increase in height and shorten in wavelength and can travel for great distances inland. The distance of travel is based on the amount of ground surface relief of the coastal region and the size of the wave.

Tsunami hazard due to submarine faulting or landsliding from both near field and far-field sources are considered as probable hazards for the California coast.

5.9.1.3 Groundwater

Groundwater seeps were not observed on-site nor along the face of the various cut, fill and natural slopes bordering the property during the 2006 site survey. Near surface groundwater does occur locally in beach bluffs and railroad cuts in North County. Review of regional groundwater data in conjunction with the nearby location of the site to the ocean and Batiquitos Lagoon, indicated that groundwater depth is approximately 50 feet below ground surface (bgs). Shallower perched groundwater, associated with landscape or agricultural irrigation, may be present on-site or in the vicinity of the site.

5.9.1.4 Flooding

The Federal Emergency and Management Administration (FEMA) maintains a collection of Flood Insurance Rate Maps (FIRM) that cover the United States. These maps identify areas that may be subjected to 100-year and 500-year cycle floods. The Ponto site is included on four FEMA flood maps consisting of panel 1027F, 1029F, 1031F and 1033F. Review of the maps indicated that the subject site is not located within a 100-year floodplain.

5.9.1.5 Landslides

Landslides are deep-seated ground failures (several tens to hundreds of feet in depth) in which a large wedge-shaped block of a slope detaches and slides downhill. Landslides differ from minor slope failures (slumps), which are usually limited to the topsoil zone and can occur on slopes composed of almost any geologic material. Landslides can cause damage to structures both above and below the slide mass. Structures above the slide area are typically damaged by undermining of foundations, while areas below a slide mass can be damaged by being overridden and crushed by the failed slope material.

Several formations within San Diego County are particularly prone to landsliding. These formations generally have high clay content and mobilize when they become saturated with water. The 2006 visual survey and geologic analysis did not identify on-site areas where landsliding has occurred, although several shallow slumps were observed near a slope associated with the railway to the east of the site.

Several graded slopes exist on the Ponto property. A westerly descending cut slope is located along the southwest side of the site, adjacent to Carlsbad Boulevard, with a maximum height of approximately 25 feet and an overall gradient of 1.3:1 (horizontal to vertical units). The upper area of this slope has gradients steeper than 1:1. Another cut slope occurs along the southeastern edge of the site and was created for the SDNR tracks that descend down grade to Batiquitos Lagoon to the south. The cut begins near the mid-portion of the site and gradually increases in height to approximately 25 feet at the southern end. The cut has an overall gradient steeper than 1:1. As mentioned, an approximately 200-foot long embankment fill slope ascends to Carlsbad Boulevard near the mid-portion of the western property boundary. This fill reaches an approximate height of 10 feet with a gradient of 1.5:1. Another on-site embankment fill was placed as part of the bridge approach for Avenida Encinas, which crosses over the SDNR tracks. A natural slope also descends downward to

Batiquitos Lagoon on the south side of the site, which reaches an approximate height of 35 feet and has a gradient of approximately 1.5:1.

Aside from the earthwork related to the railway and on-site roadway projects, the site has undergone minor grading to accommodate the construction of various building pads in the northern portion of the site. It is estimated that this work consisted of cuts and fills of less than five feet in depth.

5.9.1.6 Expansive Soils

Expansive soils are characterized by their ability to undergo significant volume changes (shrink or swell) due to variations in moisture content. Soils prone to these effects are fine-grained clays and sometimes silts. Changes in soil moisture content can result from precipitation, landscape irrigation, utility leakage, roof drainage, perched groundwater, drought, or other factors and may result in unacceptable settlement or heave of structures or concrete slabs supported on grade. Sandy soils on-site have very low clay content.

5.9.1.7 Collapsible Soils

Collapsible soils are comprised of low-density open grain soil material with a high void ratio. These soils can support light to moderate building loads for years with no noticeable adverse settlement. However, when these soils become saturated under load, the soils often fail due to hydro-consolidation, resulting in settlement (collapse). Soils most prone to collapse typically consist of recently laid alluvial sands and silty sands deposited during flash flood type events. The soils underlying the subject site consist of dense sands and are generally not prone to collapse.

5.9.2 Thresholds for Determining Significance

For purposes of this EIR a significant impact relating to geology and soils would occur if the proposed project would:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
    i. Rupture of a known earthquake fault as delineated on the most recent Alquist-Priolo Earthquake Fault Zone Map;
    ii. Strong seismic ground shaking;
    iii. Seismic-related ground failure, including liquefaction; or,
    iv. Landslides.
- Result in substantial soil erosion or loss of topsoil;
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse; or,
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code.

5.9.3 Environmental Impact

5.9.3.1 Geology

In general, the geologic evaluation determined that potential geologic impacts at the site are minimal and that the site is suitable for development as envisioned under the Ponto Beachfront Village Vision Plan. Soils are supportive of site development, as expansive or collapsible soils are not anticipated to represent hazardous conditions, and the threat of damage caused by landslide is low. Future individual projects on the Ponto site would be subject to the minimum design requirements of the Uniform Building Code at the time development occurs, to address special conditions that may affect design or construction. Therefore, potential impacts are considered less than significant.

5.9.3.2 Seismicity

As the project site is located in the seismically active Southern California region, structures constructed on the site will be subjected to seismic shaking during their lifetime. The principal seismic considerations for most projects in Southern California are damage caused by surface rupturing of fault traces, ground shaking, seismically-induced landslides, ground settlement, or liquefaction. The seismic hazard most likely to impact the project site is ground shaking resulting from an earthquake on one of the major active regional faults. The closest active faults to the site are associated with offshore extensions of the Rose Canyon Fault Zone and occur approximately three to five miles west of the site. Ground motion at the site estimated through the California Geologic Survey website indicates maximum accelerations of approximately 0.3g at a 10% probability of being exceeded in a 50-year period. Although the project site may experience seismic shaking during a major earthquake, the project is not anticipated to expose future residents or visitors to potential substantial adverse effects as a result of site development. To reduce the potential effects of seismic shaking, all development proposed would be required to be designed in accordance with the latest (2001) edition of the California Building Code (CBC) for Seismic Zone 4.

The potential for hazards caused by ground rupture is not considered significant, as no active or potentially active faults are known to cross the project site. The potential for hazards caused by liquefaction, settlement, or both, is also considered to be low, due to the dense condition of on-site soils and the apparent absence of a near-surface groundwater table. Therefore, potential impacts relative to hazardous conditions as the result of ground rupture, liquefaction, or settlement would be less than significant.

Recent research indicates that the greatest tsunami threat to the Southern California coast may be from near-field events on sections along offshore faults from San Diego. For San Diego County, it is estimated that the maximum run-up for an event on one of these fault sections could be up to 6.5 feet. Due to the elevation of the project site at approximately 30 to 70 feet amsl, potential impacts relative to hazardous conditions as the result of a tsunami are considered to be less than significant.

5.9.3.3 Groundwater

Adverse impacts or hazardous on-site conditions resulting from a shallow groundwater table or unstable soils are not anticipated to result with development of the subject site. Liquefaction is generally considered a constraint when groundwater is present. Depth to

groundwater at the project site is estimated to be approximately 50 feet bgs. As stated above, based on the dense soils that occur on-site and the absence of near-surface groundwater, hazards with respect to liquefaction would be considered low. Site development would include appropriate drainage provisions for control and drainage of surface runoff to reduce the potential for adverse impacts caused by inadequate drainage facilities; refer to Section 5.10. Therefore, potential impacts relative to hazards caused by groundwater are considered to be less than significant.

5.9.3.4 Flooding

Review of the Flood Insurance Rate Maps revealed that the site is not mapped within either a 100-year or a 500-year floodplain. The closest mapped flooding area to a 100-year zone abuts the bottom of the Batiquitos slope to the south of the site. Therefore, potential impacts relative to hazardous conditions as the result of flooding would be less than significant.

5.9.3.5 Landslides

The potential for landsliding was considered for instability within the site boundaries, as well as on slopes adjacent to and off-site of the property. The most notable slope within the property boundary is the bridge embankment for the Avenida Encinas over-crossing. The site is also nearby or adjacent to several slopes that were addressed in the geologic analysis. These slopes include the beach bluff to the west of the site, the natural slope to the south of the site that descends downward to Batiquitos Lagoon (Batiquitos Slope), the cut slope along the east side of the site for the railroad line (Railroad Cut Slope), and the cut slope along the western side of the site, adjacent to the southwest boundary with Carlsbad Boulevard (Boulevard Cut Slope).

No landslides were identified on the Ponto site. Conditions along the manufactured and natural slopes both on- and off-site were not indicative of the potential for landslides to occur. Construction or improvement of manufactured slopes required for future development of the Ponto Area would be subject to review and approval by the City, and designed in conformance with City engineering design standards. Although some signs of natural erosion and shallow slump failures were evident, the potential for landslides to occur is considered to be low. Therefore, potential impacts relative to hazardous conditions as the result of landslides would be less than significant.

5.9.3.6 Expansive Soils

Expansive soils are characterized by their ability to undergo significant volume changes (shrink or swell) due to variations in moisture content. Soils prone to these effects are fine-grained clays and sometimes silts. Due to the apparent very low clay content of the sandy soils on the Ponto site, expansive soils are not anticipated to result in a significant hazard. Therefore, potential impacts relative to hazardous conditions as the result of expansive soils would be less than significant.

5.9.3.7 Collapsible Soils

Collapsible soils are comprised of low-density open grain soil material with a high void ratio. Soils most prone to collapse typically consist of recently laid alluvial sands and silty sands, deposited during flash flood type events. The soils underlying the Ponto site consist of dense

sands deposited during the late Pleistocene and Eocene time, and hazard with regards to collapse is considered to be low. Therefore, potential impacts relative to hazardous conditions as the result of collapsible soils would be less than significant.

5.9.3.8 Erosion

The geologic materials underlying the site are composed of poorly graded sands and silty sands, which typically are weakly cemented. As such, they are prone to erosion on unprotected slopes. The amount of potential erosion is related to the steepness and height of the slope as well as the quantity of runoff that flows over the face of the slope. The cut slopes (Railroad and Boulevard slopes) surrounding the southern end of the Ponto Area are currently undergoing a moderate amount of erosion. This erosion is due primarily to surface water flow over the face of the slope which results in the formation of rills and gullies. Rilling is characteristic on slopes consisting of weakly-cemented sandy materials, and is well established on both the Railroad and Boulevard slopes. The Batiquitos slope also exhibits rills but to a lesser amount due to its lower gradient and better-established vegetation cover.

Development of the Ponto Area is not anticipated to result in substantial soil erosion or loss of topsoil during grading activities, due to on-site soil types and existing site topography. Disturbance of the ground surface during construction of any proposed development may increase or decrease the erosion potential of the site. Proper grading techniques (with appropriate compaction efforts), use of stormwater pollution prevention devices, revegetation of disturbed areas, and construction of appropriate drainage provisions would reduce the potential for erosion on-site. The project would be designed and constructed in accordance with properly-engineered grading and drainage plans and would not negatively impact the erosion potential of the site and surrounding areas.

All graded slopes resulting during development within the Ponto Area would be required to conform to minimum design requirements of the City of Carlsbad, the Uniform Building Code, and any recommendations given in the Geologic Hazards Evaluation (Appendix H) to reduce the potential for damage to occur from erosion. Compliance with these performance standards would minimize the potential for soil erosion to result during development of the site. Therefore, potential impacts relative to hazardous conditions as the result of erosion are considered to be less than significant.

5.9.4 Mitigation Measures

All future development on the Ponto Beachfront Village site would be subject to the minimum design standards of the California Uniform Building Code, the City's Excavation and Grading Ordinance (Section 15.16, Carlsbad Municipal Code), City Standard Conditions of Approval, City of Carlsbad Landscape Manual, and recommendations given in the Geologic Hazards Evaluation; refer to Appendix H. Conformance with the above regulations and standards is mandatory, and, therefore, not considered as mitigation.

The development of individual properties within the Ponto area would require preparation of grading plans for submittal to the City for review to show compliance with grading standards and manufactured slope revegetation requirements. In addition, all applicable federal, state, and local permits pertaining to drainage shall be obtained, including but not limited to, the National Pollution Discharge Elimination System (NPDES) permit from the Regional Water Quality Control Board. Compliance with these performance standards and incorporation of

site-specific geotechnical design measures into design and construction plans would reduce potential impacts related to geologic conditions to less than significant.

5.9.5 Impact After Mitigation

No significant impacts related to geologic hazards on-site have been identified. Therefore, mitigation measures are not proposed.

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Figure 5.9-1
Regional Geology Map

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Figure 5.9-2
Fault Map and Epicenters of Earthquakes

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